ANALYSIS OF HYDRO-LITHO-STRUCTURAL DOMAIN IN PRECAMBRIAN METAMORPHIC ROCKS IN PURULIA DISTRICT, WEST BENGAL, INDIA USING BEDROCK STUDY, REMOTE SENSING AND GEOPHYSICAL TECHNIQUES

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By

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SYNOPSIS

Assessment of potential groundwater recharge sites and sustainable water resource management in semi-arid crystalline rock terrain is a challenging task. Hydrological properties within hard crystalline rock terrain are completely controlled by distribution and connectivity of secondary porosity and it exhibits extreme variations over short distances imposing a great challenge for hydrogeologists to identify the locations for high yielding wells. As most of the world is comprised of hard crystalline rocky terrain, which is also true for Indian sub-continent, assessment of potential groundwater recharge sites over such hard rock terrain is the need of the hour. Remote sensing satellite imagery data analysis for delineation of groundwater potential zones over sheared crystalline hard rock terrains has been actively studied as in hard rock terrain, shear zones are known to produce well connected secondary porosity zones. It involves analysis of distribution of lineaments and their relation with each other to delineate potentially good groundwater resource sites as lineaments are representation of surface structural features such as faults, fractures, joint plane, shear zones all of which contributes to secondary porosities. Therefore, various lineament-based analysis has been used for groundwater resource investigation. But, the rate of success of delineation of good groundwater prospecting zones is very limited. Often shear zones delineated utilizing satellite imagery data has resulted unsatisfactory results as far as groundwater potentiality is concerned. Using well established methods like remote sensing satellite imagery data, analysis of structural features representing secondary porosity, water table fluctuation data analysis over crystalline terrain all

such factors have been used individually or in a combination to delineate potential groundwater recharge sites which once again has been partly successful. This suggests that there exists a gap in understanding of the hydrogeological setting of fractured aquifer terrains and groundwater occurrence and movement through those fracture zones. Also, there is no suitable method that exists by which only the lineaments which are associated with hydrologically potential fractures can be delineated. Even though shear zones have been traditionally linked with potentially good groundwater recharge sites in hard rock terrains, there is no existing study present at our disposal which discusses the factors controlling the inconsistent groundwater potentiality along the shear zones. Therefore, this study attempts to delineate the lineaments, associated with fractures, actively promoting groundwater recharge. This study also made an effort to analyse the major geological factors controlling the irregular groundwater potentiality of shear zones within older crystalline rock terrain of Purulia district, West Bengal, India.

This study area is chosen for the research purpose as the entire Purulia district is composed mostly of Precambrian high grade metamorphic rocks i.e., quartzite, granite gneisses, porphyroclastic granite-gneiss, quartzo-feldspathic-granite-gneiss, mylonitic granites, quartz-biotite-granite gneiss, quartzites, carbonatites and phyllites along with two well-known shear zones namely North Purulia Shear Zone (NPSZ) and South Purulia Shear Zone (SPSZ). Most of the northern and central parts of the study area is composed of high-grade metamorphosed granite-gneissic rocks part of the Chhotanagpur Granite Gneissic

Complex (CGGC) while along the southern border of the district, metapelitic rocks part of the Singbhum group is dominantly present.

Satellite imagery study of IRS-P6 LISS IV standard FCC image is used to analyse the entire study area to delineate structural features representing secondary porosity distribution in the form of lineaments. Careful analysis of different lithotypes, structural features of rocks, fracture property, soil thickness analysis with detail study of the composition of the soils distributed over the study area has been done. Results from theses methods has been combined with water table data evaluation with an emphasis on high water table fluctuation and Electrical Resistivity Tomography (ERT) data analysis. A combination of all the results derived from different analysis illustrated a strong spatial correlation of potentially good groundwater recharge zones and specific locales present over the two shear zones within the study area.

Detailed fracture analysis is done to understand the role of groundwater flowing fractures and its relationship with development of lineaments. This analysis led to formation of a method by which lineaments which are actively associated with significant groundwater recharging fractures could be successfully recognized and extracted from the lineament map of the study area. A directional concurrence has been noticed between hydraulically important fractures and some lineaments and it has been demonstrated how mathematical set theory can be successfully used to extract such hydraulically significant lineaments (HSL) directly from lineament map. Additionally, this research analysis constructs a detailed hydro-litho-structural model which demonstrates the most favourable groundwater recharge zones in crystalline hard rock

terrain. The results show that the lithological and structural properties existing over the SPSZ is responsible for development of significantly high numbers of lineaments and intersecting lineaments, formation of intense weathered-fractured zones resulting in development of a highly permeable zone, facilitating excellent groundwater movement and recharge. Thus, it can be concluded that the locales of bifurcating shear zone are most significant groundwater recharge sites in Precambrian metamorphic rock terrain. While the presence of heterolothitic units within the bifurcating shear zones can further increase the groundwater recharge potentiality of such crystalline hard rock terrain.

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